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Computational Simulation on Ic Cooling using Water Based Zno, Aln And Al_2o_3 Nanofluids

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Abstract**: *In obstinate attention, CFD codes got established and executed with water based ZnO, AlN and Al_2O_3 nanofluids to envision the thermal alarms of ICs. The convective governing equalities of mass, force and drive are computed for envisaging the thermal issues of ICs. The time pace selected throughout the intact computation is 0.0001 s. The soundings affect CFD forecasts of temperature curve, temperature arena plus fluid-solid boundary temperature of IC. Corresponding fluid-solid boundaries temperatures of IC are viewed as 348, 312 and 329 K for water based ZnO, AlN and Al_2O_3 nanofluids, respectively. The temperature of water-AlN nanofluid stands peak contiguous to the IC locality as it stands far less than the chancy temperature limit of 356 K. Further, the temperature of water-AlN nanofluid gently drops with improvement in aloofness from IC. Afterwards, this becomes surrounding temperature in the distant arena precinct. The analogous tinted temperature curve stands accessible. Besides, the harmonizing graph of temperature against distance from IC stands revealed. The fruition of CFD understanding remain near the skills of postures.***

Index Terms**: *CFD Codes, Heat Dissipation, ZnO, AlN and Al_2O_3 Nanofluids.***

I. INTRODUCTION

A cursor of heat tolerances in certain devices from interconnects to server remain inveterate in figure 1. Electronics heat dissipation caught numerous routines for illustration.The standard heat dissipation arrayed heretofore for instance, atmospheric convection is inappropriate for extreme thermal flux treatments. In the preceding years the strange way of heat dissipation has compelled the researchers for the wearisome of nanofluid temperature control.

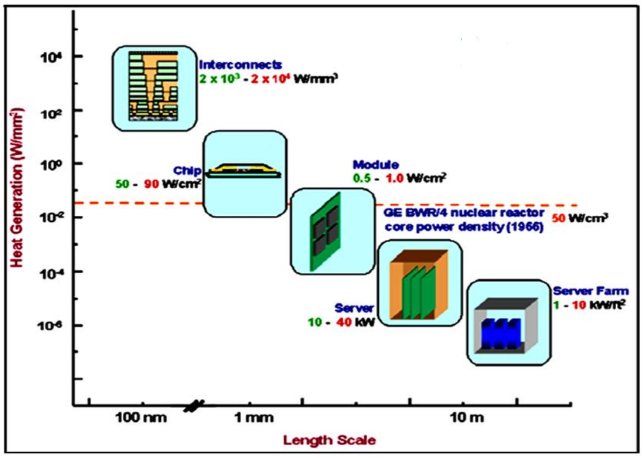

Figure 1. Continuous development of electronic devices

Besides, the nanofluid heat control is unambiguously vigorous as ambient heat dissipation is poor to deliver the drive. Numerical and experimental reviews on heat spreading over rectangular domain are existent in texts [1-7]. Computational and experimental work with solidification remain exposed as well [8-20].

Nonetheless of the evidences that the nanofluid cooling equivocates the issues about the extreme heat battle as to ambient heat dissipation and hence, the treatment of nanofluid remains the significant drive of the extant exploration. Here, the heat dissipations of electronics through water based ZnO, AlN and Al_2O_3 nanofluids remain snooped scientifically.

II. DEMONSTRATION OF PHYSICAL ISSUE

Figure 2 displays the physical issue involving the heat evolution from integrated circuit (IC) indicating the foot edge. Rest three edges are signposted through ambient situations. Here, the thermal controls of electronics is done through water based ZnO, AlN and Al_2O_3 nanofluids. Besides, the thermophysical and model data of nanoparticles reflected in the existent analysis plus the ambient situation involved in the present path simulations, are well-run in Table 1 as well.

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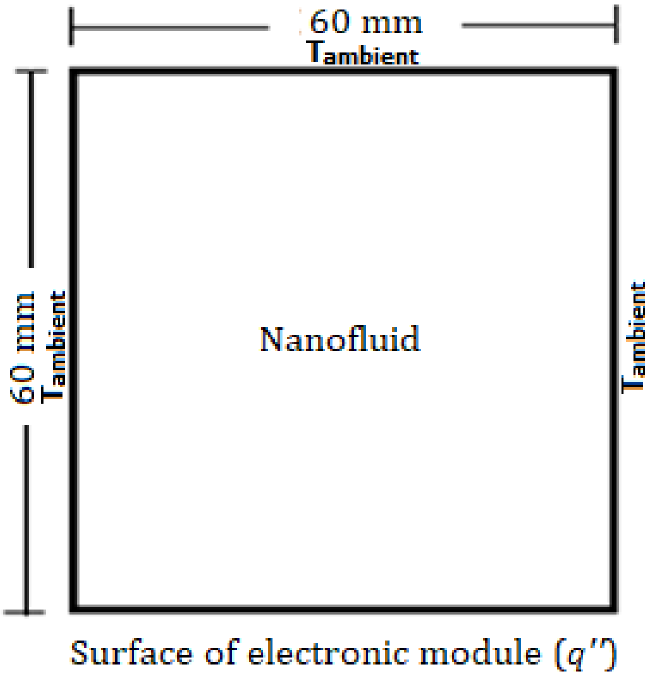

Figure 2. Pictorial illustration of IC computational zone

Table 1. Thermophysical properties and model data.

Nanoparticle Properties	**ZnO**	**AlN**	**Al_2O_3**
Density, ρ (Kg/m^3)	5607	3261	3970
Specific heat, C_P (J/kg.K)	668	741	765
Heat conductivity, k (W/m.K)	14	286	36
Model Data	**Values**		
Cavity size	60 mm		
IC size	60 mm		
Ambient temperature	300 K		
IC heat transfer rate/area	70 W/cm^2		

III. NUMERICAL TECHNIQUE

As acknowledged overhead, the figure 2 discloses the CFD worktable aimed at computing the physical topic course. To facilitate the CFD forecasts the binding stages such as constructing geometry and purview, meshing and initialization are followed to run the simulation. Here, the prevailing equalities (as termed below through equalities 1-4) of mass, force and drive beside the edge states are chosen. Linearized equalities are computed through the CFD codes. After the development of computations, CFD codes form the shapes and curls through that numerous graphs stand strained to amalgam the CFD forecasts through the prognoses. With the later dispensation the forecasts are scrupulously explored designed for accepting lavish penetrations.

Continuity: $\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$ (1)

X-momentum:

$$\rho\left(\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial v}{\partial y}\right) = -\frac{\partial P}{\partial x} + \mu\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right) \quad (2)$$

Y-momentum:

$$\rho\left(\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y}\right) = -\frac{\partial P}{\partial y} + \mu\left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2}\right) + \rho g\beta\Delta T \quad (3)$$

Energy:

$$\left(\frac{\partial T}{\partial t} + u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y}\right) = \alpha\left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2}\right) \quad (4)$$

In the present investigation, CFD codes are developed and executed with water based ZnO, AlN and Al_2O_3 nanofluids to visualize the thermal concerns of ICs. The convective governing equalities of mass, force and drive are computed for envisaging the thermal issues of ICs. The time step chosen during the whole simulation is 0.0001 s.

IV. RESULTS AND DISCUSSION

CFD codes got established and performed with water based ZnO, AlN and Al_2O_3 nanofluids. It envisages the impacts on thermal control of ICs. The soundings affect CFD forecasts of temperature fields, temperature contours and fluid-solid boundaries temperatures of ICs.

Influence of Water-ZnO Nanofluid on IC Cooling

Figure 3 unveils the CFD projection of temperature field besides the tinted measuring scale screening the temperature values over K. It stands viewed at the documented archetype statuses bearing in mind the water-ZnO nanofluid for IC heat dissipation. The fluid-solid boundary temperature of IC is viewed as 348 K. This stands far less than the chancy limit of 356 K temperature wished for the objective of outwitting thermal cataclysm of IC. The temperature of water-ZnO nanofluid remains top neighboring to the IC vicinity.

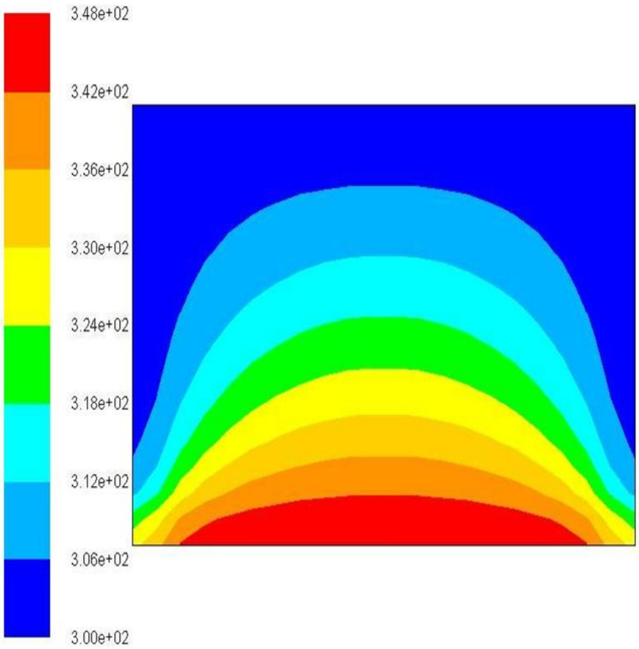

Figure 3. Temperature field with water-ZnO nanofluid

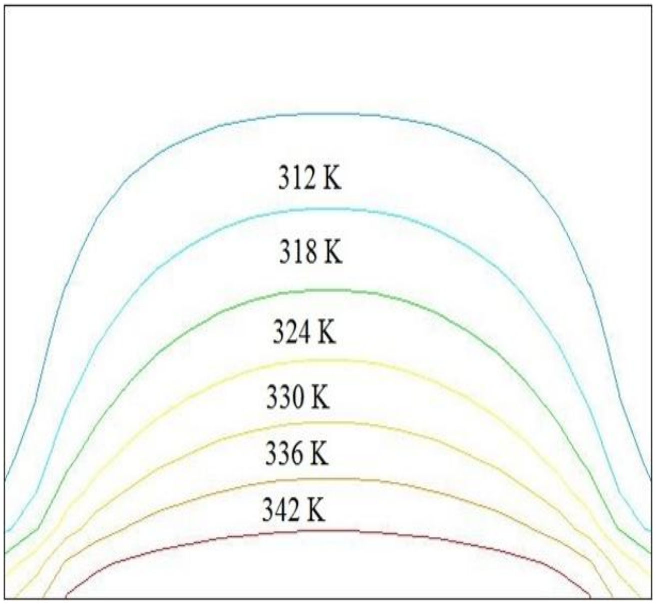

Figure 4. Temperature contour with water-ZnO nanofluid

Furthermore, the temperature of water-ZnO nanofluid smoothly drops with improvement in aloofness from IC. Afterwards, this becomes surrounding temperature in the aloof arena precinct. The equivalent tinted temperature contour stays available in figure 4 on top.

Influence of Water-AlN Nanofluid on IC Cooling

Figure 5 unveils the CFD projection of temperature field besides the tinted measuring scale screening the temperature values over K. It stands viewed at the documented archetype statuses bearing in mind the water-AlN nanofluid for IC heat dissipation. The fluid-solid boundary temperature of IC is viewed as 312 K. This stands far less than the chancy limit of 356 K temperature wished for the objective of outsmarting heat upheaval of IC.

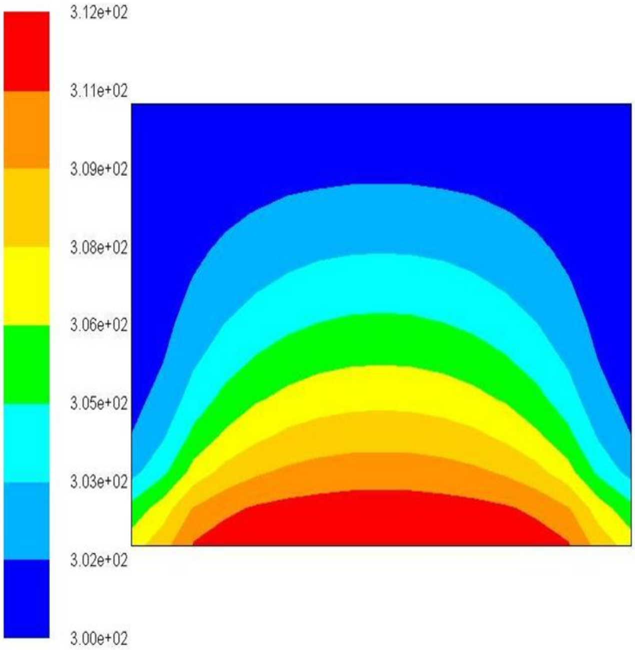

Figure 5. Temperature field with water-AlN nanofluid

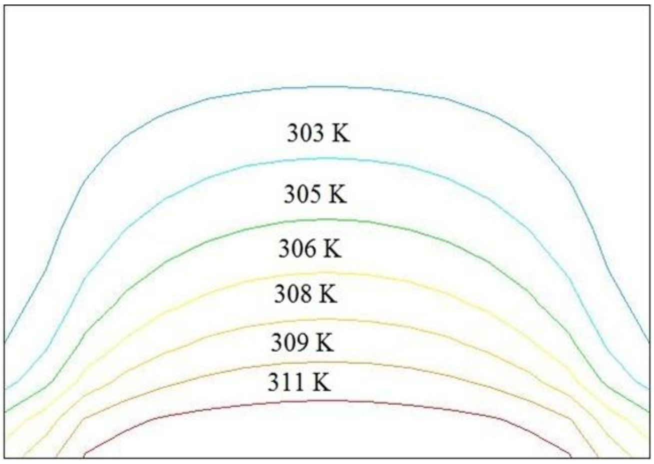

Figure 6. Temperature contour with water-AlN nanofluid

The temperature of water-AlN nanofluid stays top neighboring to the IC vicinity. Further, the temperature of water-AlN nanofluid gently drops with improvement in aloofness from IC. Afterwards, this becomes surrounding temperature in the aloof arena precinct. The equivalent tinted temperature contour stays available in figure 6 on top.

Influence of Water-Al_2O_3 Nanofluid on IC Cooling

Figure 7 discloses the CFD prediction of temperature field besides the tinted measuring scale screening the temperature values over K.

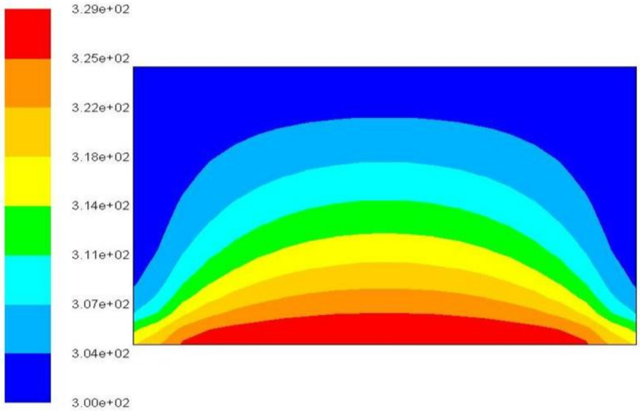

Figure 7. Temperature field with water-Al_2O_3 nanofluid

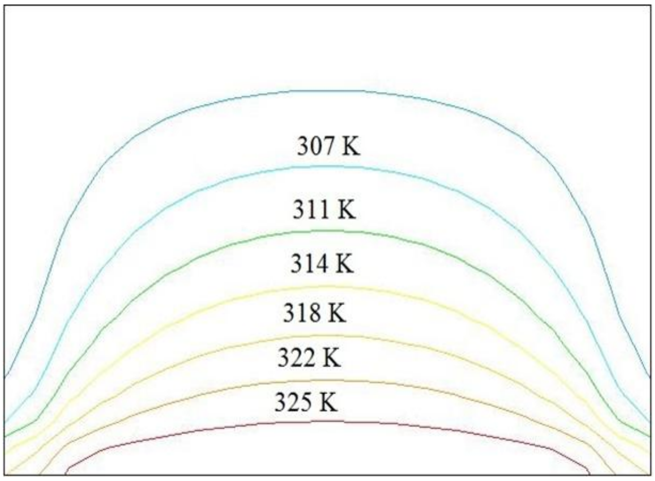

Figure 8. Temperature contour with water-Al_2O_3 nanofluid

It remains observed at the predictable epitome standings bearing in mind the water-Al_2O_3 nanofluid for IC thermal control. The fluid-solid boundary temperature of IC is viewed as 329 K. This stands far less than the chancy limit of 356 K temperature wished for the objective of outwitting thermal cataclysm of IC. Tritely, the temperature of water-Al_2O_3 nanofluid stands peak contiguous to the IC locality. Further, the temperature of water-Al_2O_3 nanofluid gently drops with improvement in aloofness from IC. Afterwards, this becomes surrounding temperature in the distant arena precinct. The corresponding tinted temperature plot stays accessible in figure 8 on top.

Table 2 summarizes the fluid-solid boundaries temperatures of ICs witnessed with water based ZnO, AlN and Al_2O_3 nanofluids. Though the trends of fields/contours results are similar, however, the discrepancies are owing to the variations in the thermophysical properties of the related nanoparticles as agglomerated in table 1. Figure 9 shows the equivalent plot of IC temperature against nanofluid.

Table 2. Summary of IC temperatures along with nanofluids.

Nanofluid	IC Temperature (K)
Water-ZnO	348
Water-AlN	312
Water-Al_2O_3	329

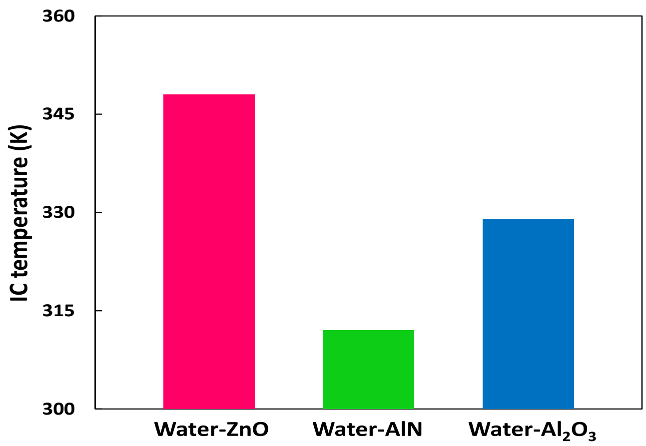

Figure 9. IC temperature vs. nanofluid

V. CONCLUSION

In stubborn thought, CFD codes are established and implemented with water based ZnO, AlN and Al_2O_3 nanofluids to envision the thermal alarms of ICs. The convective governing equalities of mass, force and drive are computed for envisaging the thermal issues of ICs. The time pace selected throughout the intact computation is 0.0001 s. The soundings affect CFD forecasts of temperature field, temperature contour and fluid-solid boundary temperature of IC. Corresponding fluid-solid boundaries temperatures of IC are viewed as 348, 312 and 329 K for water based ZnO, AlN and Al_2O_3 nanofluids, respectively. The temperature of water-AlN nanofluid remainss top neighboring to the IC vicinity, however, it stays far less than the chancy temperature limit of 356 K. Further, the temperature of water-AlN nanofluid gently drops with improvement in aloofness from IC. Afterwards, this becomes surrounding temperature in the distant arena precinct. The analogous tinted temperature curve stands accessible. Besides, the harmonizing graph of temperature against distance from IC stays exposed. The establishment of CFD investigation remain together with the proclivities of carriages.

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Dr. N. K. Kund has obtained both M.Tech. & Ph.D. in Mechanical Engineering from Indian Institute of Science Bangalore. He has also obtained B.Tech.(Hons) in Mechanical Engineering from IGIT Sarang, Utkal University Bhubaneswar. He has published several research papers in international journals and also guided many research scholars, besides, wide teaching and research experience. He is presently working as Associate Professor in the Department of Production Engineering, VSSUT Burla (A Government Technical University).